southwest and overlap a large area underlain by shallower Green River sand lenses. Gas, apparently commercial, has been found in the Ute Trail area, which includes the Ouray, Bitter Creek, Chapita Wells, and the Southman Canyon discoveries.

Gas occurs in lenticular sands near the middle of the red, drab and gray Wasatch shale section, at depths ranging from 5,000 to 6,500 feet. Porosity averages 12% and permeability less than 1 millidarcy. Some sand bodies are continuous for four or five miles. Two or three sands 20 feet thick are generally encountered in each well.

Paleogeographic maps and cross-sections show the gas sands to lie on the north edge of a wedge of deltaic clastics brought into the basin from the south, and possibly east, and deposited in a shallow lake. This interpretation differs from published descriptions of the Wasatch as "dominantly fluviatile." Orientation of sand lenses, sorting of sand grains, and relatively great lateral extent of the sand bodies supports this concept.

Trapping is by isolation of the sand bodies and by permeability barriers between lenses of porosity within a sand zone. The trend is limited on the south by a coalescence and thickening of sand bodies, which eliminates the barriers and permits the escape of gas. Hydrodynamic traps may be present here as well. The north edge is limited by poorer sorting of the sand depsoited in deeper water. Shales of the deeper water are generally dolomitic, black, bituminous and somewhat fossiliferous, and dark gray-green or drab with subordinate purplish "relict" red colors.

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Small Pseudochitinous and Resinous Microfossils: New Tools for Subsurface Geologist

The study of palynomorphs (small, nearly indestructible fossils) is generally included in the field of palynology, along with the study of polospores. Palynomorphs and polospores are included in a group of fossils sometimes designated as micro-microfossils because of their small size. Work in the Williston Basin and other areas containing Paleozoic carbonate rocks indicate that certain groups of palynomorphs make an ideal tool for use by the subsurface geologist. These fossils, chiefly the Chitinozoa (possibly an extinct order of marine protozoans) and Tasmanites (probably a family of fossil algae), may be concentrated in and recovered from the insoluble residue from drill chips utilized in the course of normal sample examination. They are well adapted for use as an aid in solving problems of correlation, zonation, and age-dating. In the Williston Basin the Chitinozoa and Tasmanites have been used as an aid in the reconstruction of the Ordovician surface section, in the subdivision of this section, and in carrying these subdivisions into the subsurface. These micro-microfossils have aided in the solution of structural problems, and offer possibilities as a tool for age-dating of Paleozoic rocks over very wide areas.

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Three Forks and Bakken Stratigraphy in West Central Saskatchewan

The Three Forks and Bakken sequence in west-central Saskatchewan was laid down during a relatively brief period of mild uplift in late Devonian and early Mississippian time, preceding the beginning of the main stage in the development of the Williston Basin. This sequence, though only about 300 feet in thickness, contains a wide variety of different rock types: dolomites, anhydritic dolomites, red beds, green shales, black radioactive shales, sandstones, and clastic biostromal limestone, which make it easily recognized in well cuttings and readily correlated from well to well.

In the northwestern part of the area the pre-Mesozoic strata were folded in post-Mississippian times, truncated and then buried by Mesozoic sediments. Data assembled from nearly all exploratory wells in the area have revealed the presence of six anticlinal structures, two of which appear to be closed and of substantial length. These structures lie in a region adjacent to producing oil fields, and therefore offer good exploration possibilities. There are indications that more hidden structures may exist in which the pre-Mesozoic strata have been folded, thus adding to further oil and gas possibilities in the area.

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Gravity Measurements East of Black Hills and along a Line from Rapid City to Sioux Falls, South Dakota

Gravity measurements were carried out in South Dakota during the summer of 1959 by the State Geological Survey, as part of a regional gravity study which is being supported by a National Science Foundation grant. A simple Bouguer gravity anomaly map was compiled from data of more than 500 stations in an area of approximately 2,600 square miles. A gravity traverse was established from the Black Hills eastward onto the Sioux uplift.

The configuration of the basement surface and the variations of intra-basement lithology, as suggested by the gravity measurements and some magnetic studies, are discussed. Interpretations of the gravity data are preliminary at this time.

Further gravity studies in South Dakota are planned.

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Gas in Gallup and "Tocito" Formations in San Juan Basin, New Mexico

Commercial quantities of gas can be produced from the Gallup and "Tocito" sandstones in nine fields on the southwest and west flanks of the San Juan basin. These fields are Bisti, Gallegos, Escrito, Otero, Doswell, Chimney Rock, Horseshoe Canyon, Verde-Gallup, and an unnamed field. The last four fields have only one to four wells with commercial quantities of gas. Most of the gas is produced with oil. Little gas was collected from the Gallup and "Tocito" prior to 1958. Some gas is being reinjected for secondary recovery purposes.

The Gallup sandstone is the basal member of the Mesaverde group. The "Tocito" sandstone is any sandstone lens below the Gallup formation and above the Sanastee calcareous shale and limestone. All accumulations are in stratigraphic traps which have increased trapping capacity because of favorable hydrodynamic environments with downdip water flow. Bisti field is used as an example of the trapping capacity of a stratigraphic trap. The sandstone decreases in permeability updip but does not pinch out. Under hydrostatic conditions the capillary pressure of the column of oil and gas present at Bisti would be sufficient to cause much of the oil and gas to migrate updip out of the permeability lenses. However, with favorable hydrodynamics, the oil and gas column of over 360 feet is retained.

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Cost of Finding Oil in Rocky Mountains